A Final Report to Investigate Engineering Solutions to Prevent Theft Due to Forgetting Credit Cards at Gordion Shopping Mall Akbank ATM

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Contents

Introduction

Introduction

Automated Teller Machine (ATM) components [1]:

- Cash withdrawal
- Cash deposit
- Credit card payment
- Open an account (deposit and time deposit account)
- Account balance inquiry
- Loan payments
- PIN code change
- Money transfers
- Display IBAN and Chip Para
- Money transfer between saving account and investment account
- Mutual fund transactions

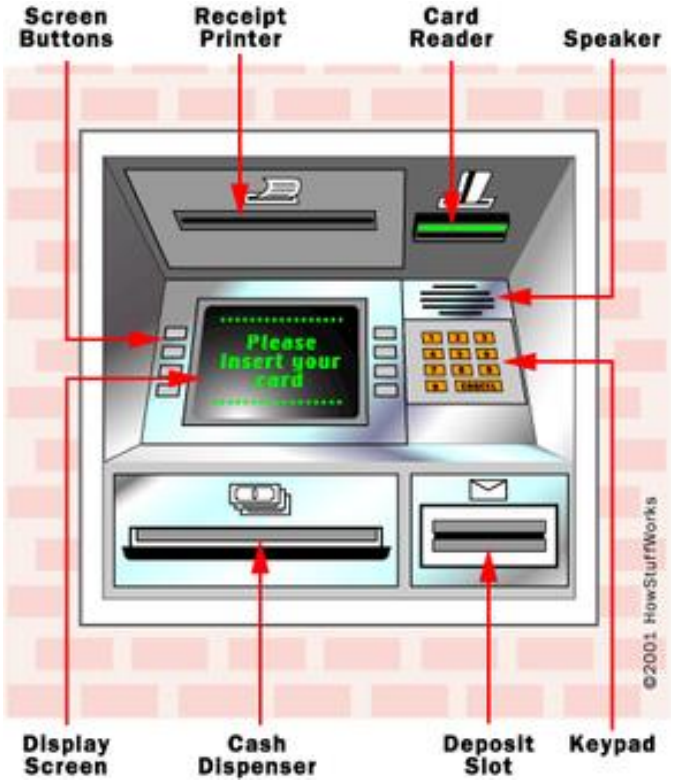


Fig. 1: Components of ATM [2]

Introduction

- ATMs are becoming the default channel for basic banking transactions [3].
- Protections against thefts and attacks in ATMs: Remote monitoring, alert systems, chip-based cards, foreign object detection [4].
- There can also be a security problem due to user error [5].

Fig. 1: User making banking transaction [6]

Pilot Study Area

- The pilot study area of this project is Gordion Shopping Mall Akbank ATM.
- Above 4.000 Akbank ATMs are 7/24 available for customers' use [7].
- Akbank ATMs allow many banking transactions such as cash withdrawals, cash deposits, balance inquiries, credit card payments, money transfers, investment funds transactions, and mobile phone top-ups [7].

Fig. 3: Gordion Shopping Mall [8]

Fig. 4: Akbank ATM [9]

Preliminary Research

- Cases of credit card and debit card fraud have increased significantly. Investigations show that this is mainly due to customer negligence: failing to take simple precautionary steps while conducting transactions [11].

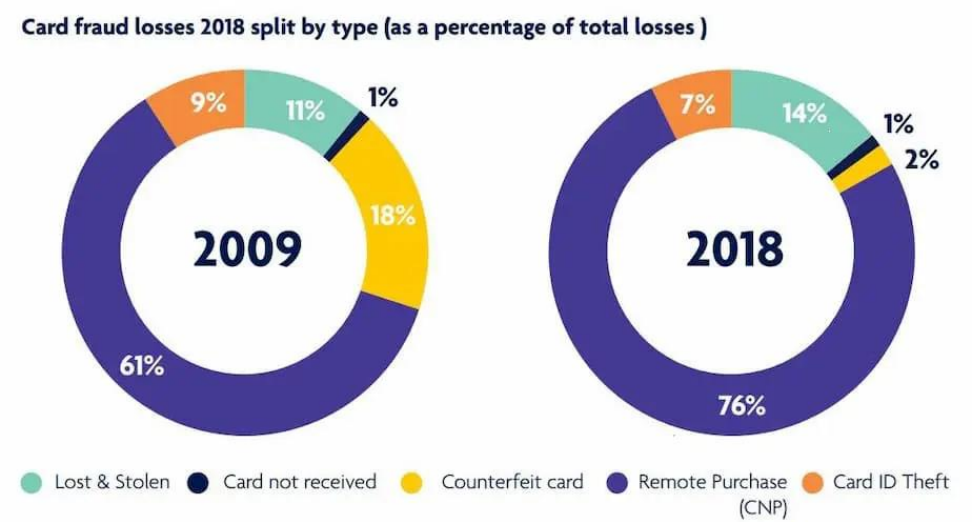


Fig. 5: Card fraud losses types [12]

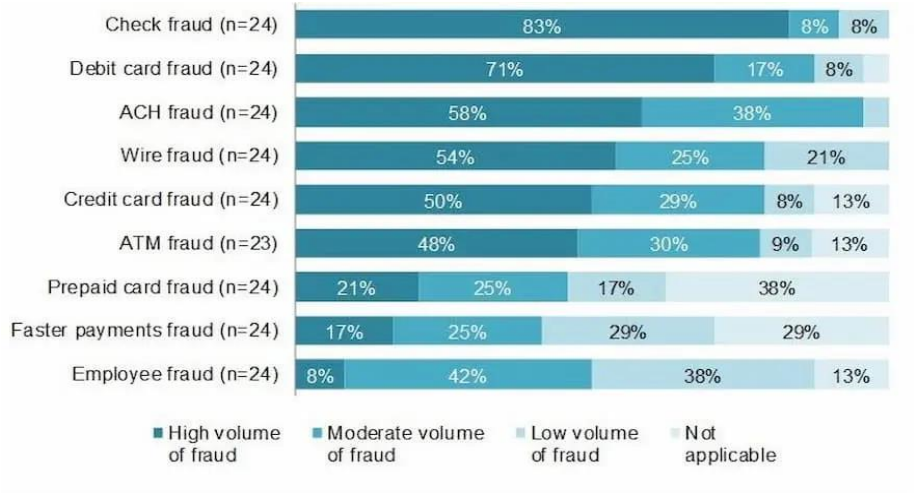


Fig. 6: Fraud detection [12]

Project's

- **Purpose:** Prevent theft due to forgetting credit cards at Gordion Shopping Mall Akbank ATM by the technical solutions.

- **Impact:** Improve the security of credit and debit cards by eliminating user error

- **Significance:** Solutions can decrease fraud loss due to credit card loss, and the solutions can be applied to all ATMs to prevent theft due to user error.

Problem Definition

Problem Definition

Fig. 7: Card reader component of an ATM [13]

- Card reader reads account information stored on a magnetic strip of credit and debit cards to retrieve the customer's account information [14].
- ATM users may forget their credit cards at the ATMs [5].
- Forgetting credit cards at Gordion Shopping Mall Akbank ATM can result in theft because a person rather than the card owner can take the card and it can be result in theft.

Fig. 8: Akbank ATM [15]

Root Causes

- The ATM rearranges the task flow by giving the credit card first and then the money to reduce user error [5].
- Rearrangement of the task flow [5] and the warning message on the screen [16] is not enough to eliminate the possibility of user error.
- Precautions are not adequate for the prevention of the problem.

Fig. 9: Warning message [16]

Problem Scope

- Who: ATM users who are Akbank Debit or Credit Card owners.
- What: Credit or debit card fraud
- When: After completion of the banking transaction
- Where: At Gordion Shopping Mall Akbank ATM
- Why: Precautions taken for forgetting credit card is not enough
- How: A person rather than the card owner can take the card

Proposed Solutions

Proposed Solutions

- Fingerprint Identification System (FIS)
- Matching the Card With the Application (MCWA)
- Collaboration of Akbank and Gordion Shopping Mall (CAGSM)

Fingerprint Identification System (FIS)

Fig. 10: Fingerprint illustration [16]

- A digital system responsible for scanning fingerprints to identify a person and grant permission or access [17].
- A series of distinct points, called minutiae, are the points the FIS uses for comparison [18].
- FIS can be used in Gordion Shopping Mall Akbank ATM for the person identification.

Fig. 11 : Fingerprint identification system in ATMs [19]

FIS

- Four modules: sensor, feature extraction, template database, and matching [20].
- The matching module compares the query and template data stored in database to arrive at a match or non-match verdict [20].
- A fingerprint identification device will be integrated next to the Akbank ATM at Gordion Shopping Mall.
- Requirements:
  - Fingerprint identicifation device
  - Network connection between the ATM and fingerprint identification device
  - An electrical and computer engineer to implement the system

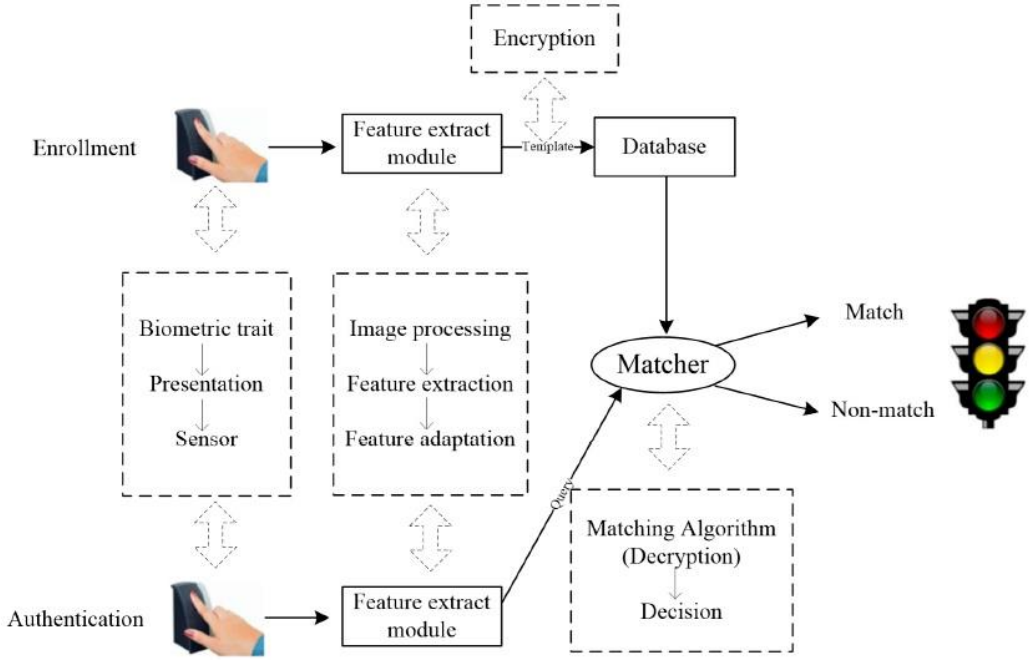


Fig. 12 : How FIS works [19]

MCWA

- Cards are embedded with a small gold- or a silver-colored microchip to securely manage the transactions [21].

- EMV chips create a unique key each time the card is used [21]. Chip identifies that transaction by a unique transaction code valid for one-time use only [22].

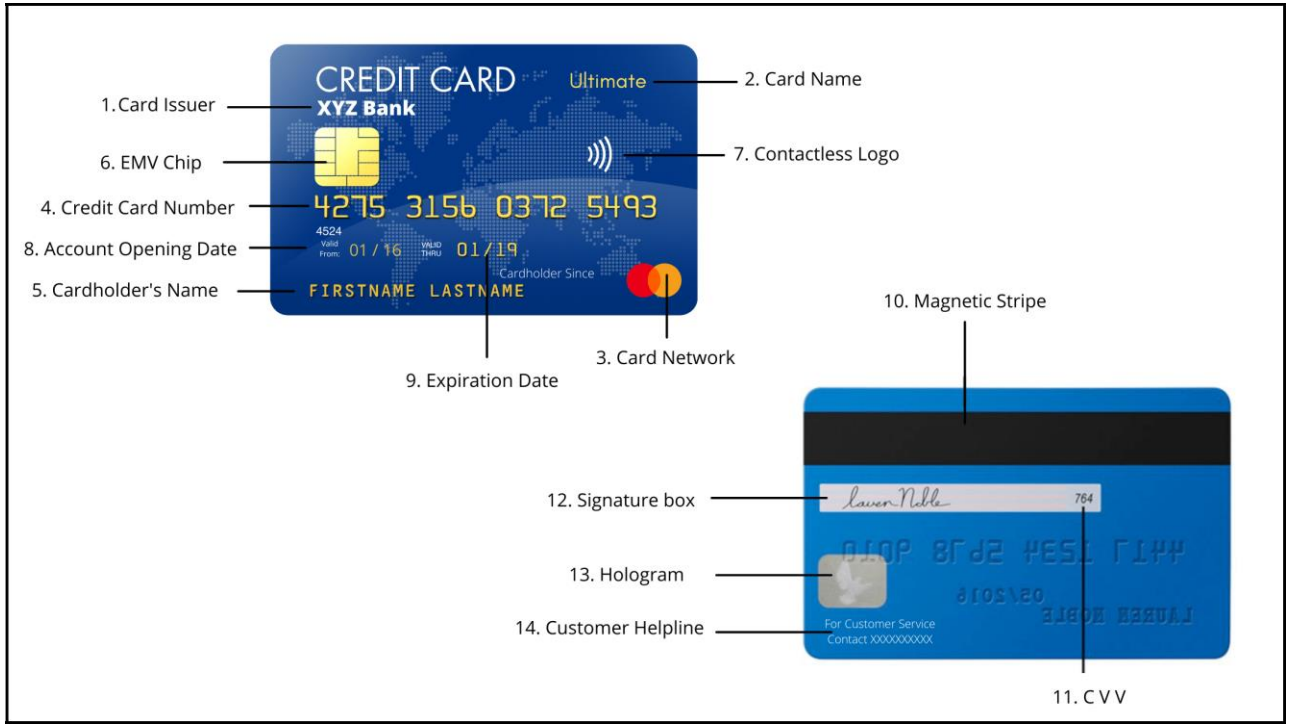


Fig. 13 : Anatomy of a credit card [23]

MCWA

- The card will be paired with the application on the user's phone or smartwatch.
- A unique transaction code created by EMV chips for one-time use only [22] will be used for the card's location detection.

Fig. 14 : EMV chip on the credit card [24]

- Distance Matrix API in Google: calculates the distance between waypoints on a map [25].
- The distance between the credit card and the location of the user will be controlled by the API in application.

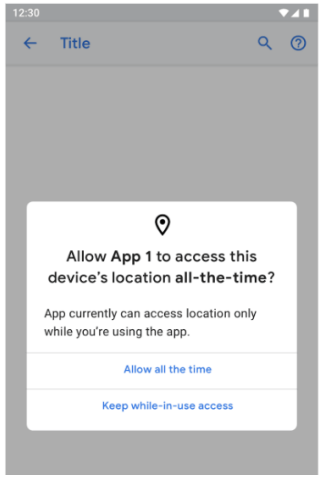


Fig. 15 : Banking application integrated with a map [25]

MCWA

- User will be notified with a notification from the application if the credit card is too far away from the user.

- Requirements:
  - Additional technological material which will be integrated to EMV chips
  - Distance Matrix API in Google
  - Computer engineer for the implementation of the API to the apllication
  - Electric engineer for the implementation and modification of the EMV chip

CAGSM

- Security tags clip a radio-frequency identification chip directly onto an item. An alarm is triggered when the chip crosses the detection sensor [26].

- Detector sends out a signal that communicates with security tags or labels on products. This tag or label then answers back via small transmitters [27].

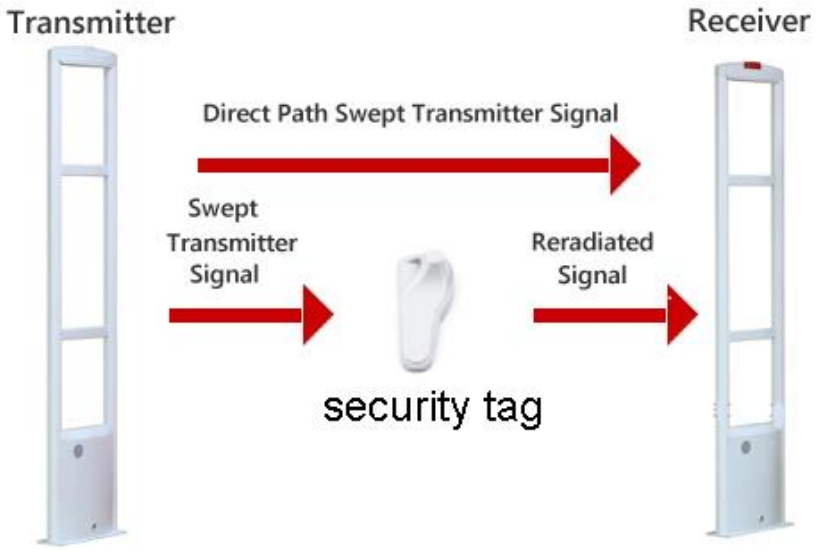


Fig. 16 : How detectors work illustration [28]

CAGSM

- CAGSM: Detection of whether the credit card is on the user or not. If it is not, then the user will be notified by a message.
- Transactional SMS messages are used for informational messages to registered customers [29].
- Requirements:
  - Security tags
  - Detector devices
  - Transactional SMS Messages System
  - Electric and Computer Engineers for the implementation

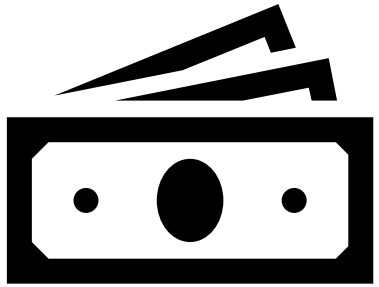
Fig. 17 : Gordion Shopping Mall [30]

Fig. 18 : Akbank [7]

Criteria for Assessing Solutions

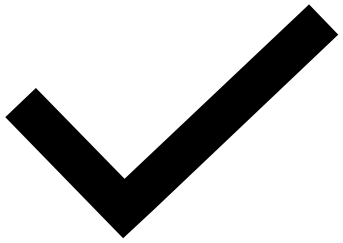
Criteria for Assessing Solutions

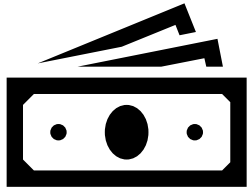
1) Cost [31]



2) Performance [32]

3) Feasibility [33]



Cost 

FIS	MCWA	CAGSM
Cost of the device and its implementation to the ATM will be investigated [16], [17], [18], [19], [20]?	Integration of the location property to the banking application and the adaptation of EMV chips for the detection of the location will be considered [21], [22], [24], [25]?	The price of the detection devices and the security tags adaptable to the credit cards will be researched [26], [27], [28], [29] ?

FIS : Fıngerprint Identification System
MCWA: Matcing the Card with Application
CAGSM: Collaboration of Akbank and Gordion Shopping Mall

Performance 

FIS	MCWA	CAGSM
The FIS system is additional property for the banking system, so the effects to the performance of the electronic device will be examined [16], [17], [18], [19], [20]?	Integration of the map property to the application may affect the app's performance in terms of speed. Also, connection requirement's effects on charge consumption will be investigated [21], [22], [24], [25]?	An additional component to the credit cards for detecting its location may affect the performance. Whether it will slown down the transaction of the credit card will be considered [26], [27], [28], [29]?

FIS : Fıngerprint Identification Sys.tem
MCWA: Matcing the Card with Application
CAGSM: Collaboration of Akbank and Gordion Shopping Mall

Feasibility ✓

FIS	MCWA	CAGSM
The followings will be considered: Can the property be used in all the versions of the ATM software system, and be adapted to the updates to the system of the ATM [16], [17], [18], [19], [20]?	The followings will be considered: In the case of a weak connection between the credit card and the application, the location of the credit card can be obtained or not [21], [22], [24], [25]?	The followings will be considered: Will the security system work properly in the case of a power cut [26], [27], [28], [29]?

FIS : Fıngerprint Identification System
MCWA: Matcing the Card with Application
CAGSM: Collaboration of Akbank and Gordion Shopping Mall

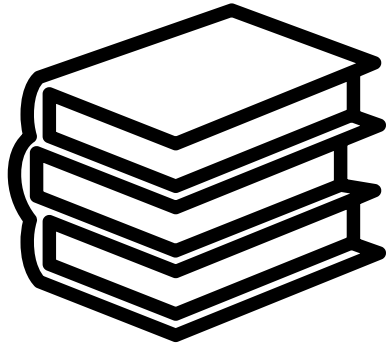
Research Methodology

Research Methodology

1) Market Research [34]

2) Expert Opinion [35]

3) Literature Review [36]



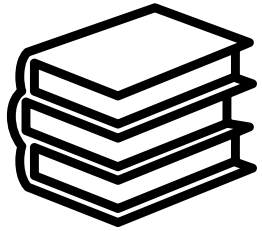
Market Research

- This research methodology will be used to assess the solutions in terms of cost criteria and the performance of the devices [17], [18], [20], [21], [22], [25], [26], [27], [29].
- The solutions require additional electronic device(s), applications, and software to integrate the properties. Therefore, a market search will be done for all the solutions to determine the differences between the prices according to the types and performance of the devices.
- 1) Implementation cost
- 2) Electronic devices' prices
- 3) Setup cost

Expert Opinion

- This research methodology will be used to assess the performance and feasibility criteria [17], [18], [20], [21], [22], [25], [26], [27], [29].
- 1) Applicability of the systems will be considered, and how the performance of the credit cards, applications on smartphones and smartwatches, and the ATMs will be affected will be determined.
- 2) The solutions' feasibility in various conditions will be investigated.

Literature Review



- This research methodology will be used to assess the solutions in terms of their performance and feasibility [17], [18], [20], [21], [22], [25], [26], [27], [29].
- 1) Investigating the systems that already use these technologies and their implementation and functionality.
- 2) Research the solutions in terms of how long they can be used and what can be done to increase the feasibility of the solutions.
- 3) Research the functionality of the solutions in corner cases.

Research Methodology

	FIS	MCWA	CAGSM
COST 	• Market research	• Market research	• Market research
PERFORMANCE 	• Expert opinion • Literature review • Market research	• Expert opinion • Literature review • Market research	• Expert opinion • Literature review • Market research
FEASIBILITY 	• Expert opinion • Literature review	• Expert opinion • Literature review	• Expert opinion • Literature review

Results and Analysis

Criteria Weigtening

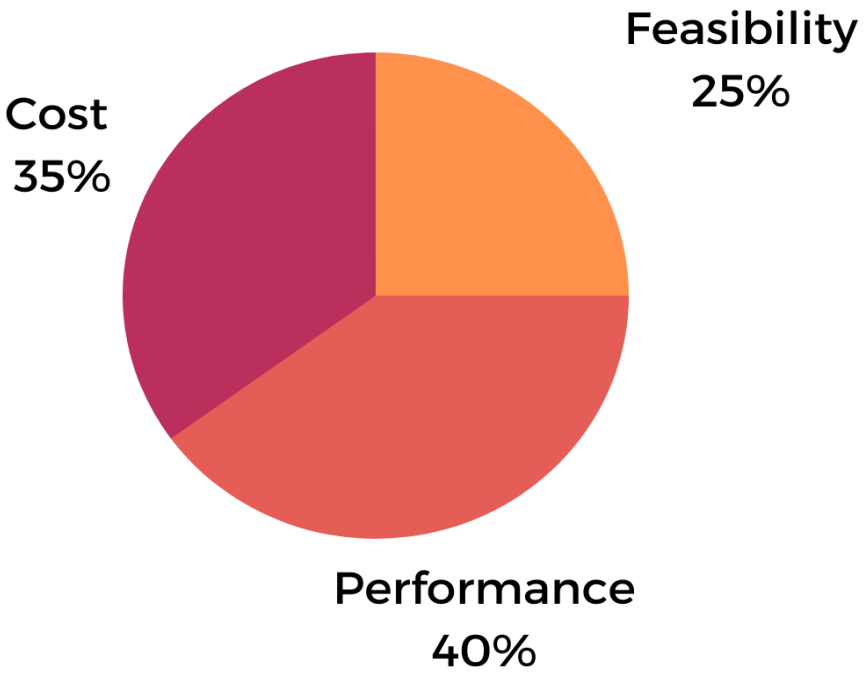


Fig. 19: Criteria Weigtening Pie Chart [37]

- **Performance criteria (40%):** Largest slice due to technological devices' performance importance
- **Cost criteria (35%):** Price of devices, components, and solution implementations require a considerable cost
- **Feasibility criteria (25%):** Least slice since the new functionalities to the technological devices are mostly adaptable and integrable

Cost Scoring (35%)

Fig. 19 : Cost criteria illustration [38]

- Financial costs are investigated
- The costs are in USD
- **Scoring process:**
  - Solution starts with the highest score
  - If another solution's cost is less
    ⇒ solution's score **decreases**
  - If another solution's cost is more
    ⇒ solution's score **decreases**

	Points	Comments
Lowest	**Good (5)**	
Median	**Unsatisfactory (3)**	
Highest	**Poor (1)**	

Performance Scoring (%40)

Fig. 20 : Performance criteria illustration [39]

	Points	Comments
1) Additional property does not affect system's response time	Yes, not affected (2) Partially, a slight increase (1) No, time increases (0	
2) Device's load scalability protected for heavy load	Yes, sufficient (2) Partially, enough to process (1) No, insufficient (0)	
3) Existing functionalities' performance not affected	Yes, not affected (2) Partially, inefficiency is potential (1) No, inefficiency in functionalities (0)	
4) Device's battery/lifespan runs out faster	Yes, charging is not affected (1) No, it runs out faster (0)	

Feasibility Scoring (25%)

Fig. 21 : Feasibility criteria illustration [40]

	Points	Comments
1) Solution adaptable to updates/new versions	Yes, adaptable (2) Partially, needs adjustment (1) No, not adaptable (0)	
2) Weak connection/power cut does not affect system functionality	Yes, functions properly (2) Partially, decrease in functionality (1) No, does not function (0)	
3) Similar examples in different areas	Yes, examples exist (1) No, not applied before (0)	
4) Additional user information acquisition not required	Yes, not required (1) No, required (0)	

FIS's Cost (35%)

Fig. 19 : Cost criteria illustration [38]

- **Fingerprint reader device (per device):** $45.00 – $700.00 [41]
- **Average cost of FIS device:** [(45 + 700) / 2] = $372.5
- **Average Network/LAN connection cost:** $440 [42]
- **Instalation of the identification device (labour):** $300 - $600 [43]
- **Average cost of installation:** [(300 + 600) / 2] = $450

Average total cost: $372,5 + $450 + $440 = $1,262.5

FIS's Cost (35%):

Average total cost: $1,262.5

Fig. 19 : Cost criteria illustration [38]

	Points	Comments
Lowest: FIS	**Good (5)**	Solutions' cost: $1,262.5
Median	**Unsatisfactory (3)**	
Highest	**Poor (1)**	

MCWA's Cost (35%)

Fig. 19 : Cost criteria illustration [38]

- **Google Distance Matrix API (monthly):** $1,000 [44]
- **Google Distance Matrix API Advanced (monthly):** $1,985 [44]
- **Average total cost of API:** [(1,000 + 1,985) / 2] = $1,492.5
- **Average total cost of EMV terminals setup**: $500 - $1,000 => (500 + 1,000) / 2 = $750 [45]

Average total cost: $750 + $1,492.5 = $2,242.5

MCWA's Cost (35%):

Average total cost: = $2,242.5

Fig. 19 : Cost criteria illustration [38]

	Points	Comments
Lowest: FIS	**Good (5)**	FIS's cost ($1,262.5) < MCWA's cost ($2,242.5)
Median	**Unsatisfactory (3)**	
Highest: MCWA	**Poor (1)**	MCWA's cost ($2,242.5) > FIS's cost ($1,262.5)

CAGSM's Cost (35%)

Fig. 19 : Cost criteria illustration [38]

- **Average total cost of detector device (per device)**: $2,899.00 - $3,519.00 =>

  (2,899.00 + 3,519.00) / 2 = $3,209.00 [46]
- **Micro security tags (per tag):** $18.99 [47]
- **Avarage setup cost of the Transactional SMS System (monthly):** $25 - $1,000 = $512,5 [48]

Average total cost: $420 + $18.99 + $512.5 = $3,740.49

CAGSM's Cost (35%):

Average total cost: = $3,740.49

Fig. 19 : Cost criteria illustration [38]

	Points	Comments
Lowest : FIS	**Good (5)**	FIS ($1,262.5) < CAGSM ($3,740.49) FIS ($1,262.5) < MCWA ($2,242.5)
Median: MCWA	**Unsatisfactory (3)**	FIS's ($1,262.5) < MCWA ($2,242.5) CAGSM ($3,740.49) > MCWA's cost ($2,242.5)
Highest: CAGSM	**Poor (1)**	CAGSM ($3,740.49) > FIS ($1,262.5) CAGSM ($3,740.49) > MCWA ($2,242.5)

Fig. 19 : Cost criteria illustration [38]

Cost Analysis

FIS Total score: 5 pt	MCWA Total score: 3 pt	CAGSM Total score: 1 pt

- CAGSM cost is higher than the other two solutions because of the detector device's high price.
- MCWA's API requirement for the banking application costs considerably
- **Compared to the other two solutions, FIS is the most cost-efficient solution.**

Fig. 20 : Performance criteria illustration [39]

FIS's Performance (%40)

Total: 6/7

	Points	Comments
1) Additional property does not affect system's response time	Yes, not affected (2) Partially, slight increase (1) No, time increases (0)	ATM's CPU and memory provide sufficient processing capabilities [49]
2) Device's load scalability protected for heavy load	Yes, sufficient (2) Partially, enough to process (1) No, insufficient (0)	Load scalability can be affected due to high collision at heavy loads [50]
3) Existing functionalities' performance not affected	Yes, not affected (2) Partially, inefficiency possible (1) No, inefficiency in functionalities (0)	Many applications can be added to the system without a side effect due to ATM's highly scalable base [51]
4) Device's battery/lifespan runs out faster	Yes, charging is not affected (1) No, it runs out faster (0)	There is no effect on the battery or lifespan [52]

MCWA'S Performance (%40) Total: 5/7

Fig. 20 : Performance criteria illustration [39]

	Points	Comments
1) Additional property does not affect system's response time	Yes, not affected (2) Partially, slight increase (1) No, time increases (0)	Response time which is dependent on communication between the card and device, will not be affected [52]
2) Device's load scalability protected for heavy load	Yes, sufficient (2) Partially, enough to process (1) No, insufficient (0)	System may not be scalable if software architecture doesn't function effectively to increase throughput [53]
3) Existing functionalities' performance not affected	Yes, not affected (2) Partially, inefficiency possible (1) No, inefficiency in functionalities (0)	Existing functionalities will not be affected by the property addition as communication is not affected [52]
4) Device's battery/lifespan runs out faster	Yes, charging is not affected (1) No, runs out faster (0)	Complex apps equipped with additional features reduce the battery life of the device [54]

CAGSM's Performance (%40) Total: 6/7

Fig. 20 : Performance criteria illustration [39]

	Points	Comments
1) Additional property does not affect system's response time	Yes, not affected (2) Partially, slight increase (1) No, time increases (0)	System response time depends on authorization and authorization request is sent by the data obtained from the processor [55], [56]
2) Device's load scalability protected for heavy load	Yes, sufficient (2) Partially, enough to process (1) No, insufficient (0)	No change between the card and the network of the banking system [52]
3) Existing functionalities' performance not affected	Yes, not affected (2) Partially, inefficiency possible (1) No, inefficiency in functionalities (0)	A card's chip can be demagnetized due to Electromagnetic security systems' electromagnetic interference [58] [57]
4) Device's battery/lifespan runs out faster	Yes, charging is not affected (1) No, runs out faster (0)	Lifespan of the credit cards depends on the expiration time set by the bank [59]

Fig. 20 : Performance criteria illustration [39]

Performance Analysis

FIS Total score: 6/7	MCWA Total score: 5/7	CAGSM Total score: 6/7

- MCWA's battery inefficiency due to application complexity with the additional feature is a drawback for performance criteria
- The possibility of a decrease in load scalability is a concern for both FIS and CAGSM
- **Both CAGSM and FIS have better performance compared to MCWA**

FIS's Feasibility (25%)

Total: 3/6

Fig. 21 : Feasibility criteria illustration [40]

	Points	Comments
1) Solution adaptable to updates/new versions	Yes, adaptable (2) Partially, needs adjustment (1) No, not adaptable (0)	Digital banking software is designed in a way that remote ATMs' potential can be expanded with the new functionalities [60]
2) Weak connection/power cut does not affect system functionality	Yes, functions properly (2) Partially, decrease in functionality (1) No, does not function (0)	FIS depends on electricity to function, so power cut will make the system unusable [61]
3) Similar examples in different areas	Yes, examples exist (1) No, not applied before (0)	Users can log in to the HSBC Mobile Banking application through fingerprint authentication [62]
4) Additional user information acquisition not required	Yes, not required (1) No, required (0)	FIS works by examining a finger pressed against a smooth surface [63]

MCWA's Feasibility (25%)

Total: 5/6

Fig. 21 : Feasibility criteria illustration [40]

	Points	Comments
1) Solution adaptable to updates/new versions	Yes, adaptable (2) Partially, needs adjustment (1) No, not adaptable (0)	All smartphones/watches have communication abilities like NFC, Bluetooth, WiFi, etc., to get and apply updates [52]
2) Weak connection/power cut does not affect system functionality	Yes, functions properly (2) Partially, decrease in functionality (1) No, does not function (0)	EMV chips don't require an internet connection. Internet connection is required for API usage [64], [65]
3) Similar examples in different areas	Yes, examples exist (1) No, not applied before (0)	Microchips are used in GPS receivers. Akbank mobile application provides the nearest branch' or ATMs locations [66], [67]
4) Additional user information acquisition not required	Yes, not required (1) No, required (0)	Required user information is stored on an embedded EMV microchip. Distance Matrix API detects the user location itself [68], [69]

CAGSM's Feasibility (25%)

Total: 5/6

Fig. 21 : Feasibility criteria illustration [40]

	Points	Comments
1) Solution adaptable to updates/new versions	Yes, adaptable (2) Partially, needs adjustment (1) No, not adaptable (0)	These are common technologies, so they will be adaptable to the changes [52]
2) Weak connection/power cut does not affect system functionality	Yes, functions properly (2) Partially, decrease in functionality (1) No, does not function (0)	Electrical field is generated only when tag's circuit comes into contact with radio waves. Backup system keeps the detector running [70], [71]
3) Similar examples in different areas	Yes, examples exist (1) No, not applied before (0)	Shopping malls have many examples to prevent theft [72]
4) Additional user information acquisition not required	Yes, not required (1) No, required (0)	Embedding a radio-frequency identification chip directly onto the card will be enough; no additional user information is required [52]

Fig. 21 : Feasibility criteria illustration [40]

Feasibility Analysis

FIS Total score: 3/6	MCWA Total score: 5/6	CAGSM Total score: 5/6

- FIS's additional user information acquisition requirement and the possibility of nonfunctioning due to power cut results in drawbacks for feasibility criteria.
- Internet connection dependency for MCWA is a disadvantage for the feasibility of the technological solution.
- Condition for the micro security tag's electric field is a negative point for feasibility
- **CAGSM and MCWA are more feasible solutions compared to FIS**

Conclusion and Recommendations

Final Scores

	Cost (35%)	Performance (40%)	Feasibility (25%)	Total Score
FIS	5/5 * 35 = 35	6/7 * 40 = 34.28	3/6 * 25 = 12.5	81.78%
MCWA	3/5 * 35 = 21	5/7 * 40 = 28.7	5/6 * 25 = 20.8	70.5%
CAGSM	1/5 * 35 = 7	6/7 * 40 = 34.28	5/6 * 25 = 20.8	62,08%

Conclusion and Recommendations

- FIS is the most cost-efficient solution among the three solutions.
- FIS performs effectively and it is feasible to be integrated into ATM.
- **FIS got the highest score among all solutions and is the recommended solution for PSA.**

Fig. 22 : Fingerprint identification device on ATM [19]

Action Plan

1) Required technological devices: fingerprint identification devices and equipment for the network connection will be ordered from the companies that sell these devices.
2) The fingerprint identification device will be integrated by Electrics and Electronics engineers.
3) Computer engineer will set the network connection and all necessary software.
4) The engineers of Akbank will test all the corner cases and the ATM and FIS functionalities.

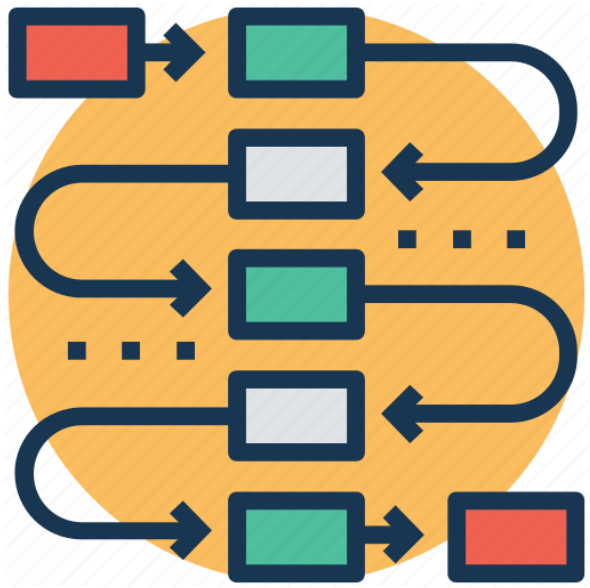


Fig. 23 : Action plan illustration [73]

Action Plan’s Gantt Chart

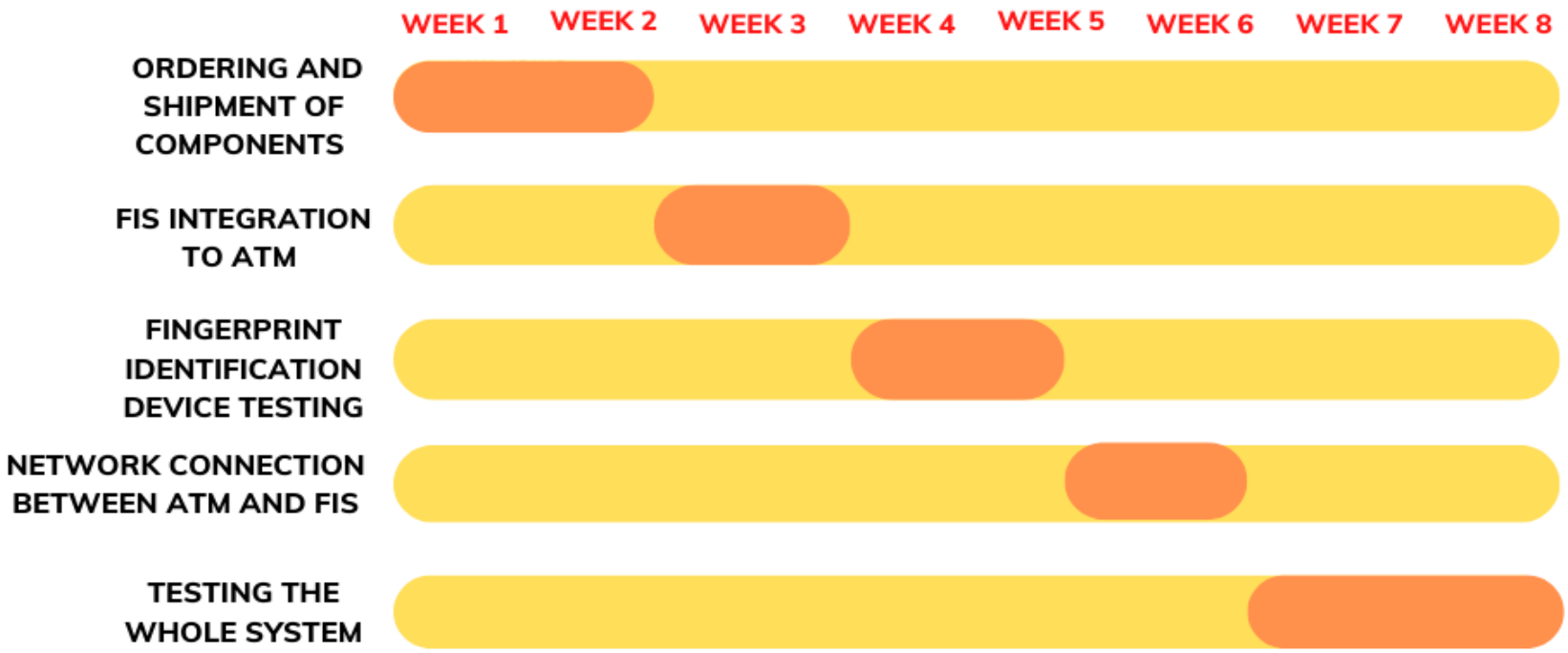


Fig. 22 : Action plan’s Gantt Chart [74]

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THANK YOU !